SITE PRODUCTIVITY ASSESSMENT

Site Index

An estimation of site productivity is important in both forest ecology and in forest management. Few forests have accurate long-term records of stand development and growth which can be measured to determine site productivity (Spurr and Barnes, 1980). Generally, productivity can only be estimated indirectly by examining indicators such as: height growth of trees, depth of soil, indicator plant species, and topography.

The height of free-grown trees[1] of a given species and of a given age is more closely related to the capacity of a given site to produce wood of that species that any other one measure. Additionally, height of free-grown trees is less influenced by density of the forest stand than other measures and may therefore be used as an index of site productivity in even-aged stands of varying density and silvicultural history (Spurr and Barnes, 1980).

Site index is the quantitative expression of the relative productivity of various forest communities (with a higher number representing higher relative productivity). Site index uses the growth of trees from the dominant and co-dominant size classes in a community to represent the overall growth potential of the forest community. Site index information obtained for the Lake Whatcom planning area was derived from FRIS plots taken in 1995 (Map H-1). Table 1 illustrates the percentage of each site class by species for trust lands in the planning area. The usefulness of this information is somewhat limited because plot values were averaged out over an entire stand. The factors that influence site productivity (slope, aspect, soil depth, water movement, etc.) can vary greatly within a short distance.

[1]Trees that have grown from the time of their establishment without a tree or brush canopy above them to suppress them or slow their development.

Table 1 – Acres Within Each Site Class by Dominant Species – Trust Lands Only

Site class	Douglas-fir acres	Hemlock acres	Red Alder acres
Site 1	788	0	0
Site 2	5506	0	0
Site 3	5705	437	249
Site 4	1081	584	799
Site 5	29	534	15

Site Productivity Factors

Site productivity may be influenced by a number of factors. Some, such as climate, aspect, and topography, will not be influenced by forest management activities. Others may be affected to differing degrees depending on soil sensitivity and level/type of activity. A discussion of some of these factors follows:

Soil depth

Total soil depth is an indicator of soil available for tree root development. In general, as depth of soil increases, site productivity increases. Because the process of creating soils takes centuries, soil depth is generally not influenced by management activities though yarding, skidding, and road and landing construction can displace soils.

Soil compaction

The height growth of trees has an inverse relationship to bulk density of soils. The bulk density of forest soils can be increased through compaction by logging equipment during timber harvest activities. In general, ground based harvest methods (wheeled or tracked machines) have a greater potential to compact soils than cable methods (highlead, skyline) or helicopter logging. Soil compaction increases with the number of passes of logging equipment. Ground based logging equipment is generally limited to slopes of less than 30 percent. The topography of state lands within the planning area is steep with limited areas of less than 30 percent. For this reason, soil compaction is less of an issue in this landscape than areas with gentler slopes.

Compaction potential differs depending on soil type (Table 2) and depth of organic matter. Thicker organic litter layers provide more resistance to compaction.

Table 2 – Compaction Potential of Differing Soil Types

Soil Type	Compaction Potential
gravelly, coarse textured, drier soil	low

intermediate textures and wetness	medium
fine textured (silts or clays), wetter soil	high

Displacement of soils

Displacement of soils from an area lowers the productivity of the site. Displacement can occur during yarding and road building activities. Cable yarding can result in logs being dragged across an area, removing the duff layer and disturbing the soils. Operation of ground-based wheeled and tracked machines also disturbs soils; more passes across a given area result in higher disturbance. Additionally, road and landing construction generally result in high displacement of soils in defined areas.

Organic Debris

Organic matter is important to tree nutrition as a source of nitrogen and other nutrient elements as well as of growth-promoting substances. Organic matter provides food and other materials for soil organisms that play an important role in the maintenance of soil fertility, particularly in the maintenance of optimum physical conditions. Although not completely understood, the role of organic matter is of importance to soil productivity.

As often as not, forest management activities indirectly affect tree growth by directly affecting the soil organisms. The organisms are vital in beneficial processes such as soil aggregation, organic matter decomposition, nitrogen transformation, gaseous nitrogen fixation, phosphorus and micronutrient solubilization and uptake, capture of nutrients that would otherwise be lost through leaching, and protection of tree roots from pathogens. Soil organisms can also harm forest productivity by aiding in formation of iron pans and highly acid raw humus, immobilizing nitrogen, or in the case of disease organisms, deteriorating roots of trees (Trappe and Bollen).

Good soil management practices favor desirable biological activity. For example, minimizing soil compaction during timber harvest maintains not only good soil physical properties but also populations of soil organisms. Retaining branches, twigs, and leaves as waste within the harvest unit during logging operations helps in the buildup of the duff layer. Clearcutting depopulates the soil more abruptly than partial cutting, especially of organisms depending on living roots for survival.

Most of the timber on state trust lands within the planning area was harvested between 1900 and 1930 with a small percentage harvested since then. Currently, state forest lands have limited diversity of stand age, species composition, and stand structures (Table 3).

Table 3 – Age Class Distribution on State Trust Lands in the Planning Area

Age Class	Acres	% of Landscape
0-5 yrs.	374	2
6-15 yrs.	1734	11
16-40 yrs.	376	2
41-60 yrs.	4873	31
61-80 yrs	5855	37
81-100 yrs	1936	12
101 - 120 yrs.	481	3
121 - 160 yrs.	44	.5
161 - 200 yrs.	74	.5
Non-forested	213	1
Total	**15,809**	**100**

Fertilization

Tree growth may be temporarily enhanced by adding fertilizers. Nitrogen has proved the most important single element generally in short supply in forest soils of the Pacific Northwest.

Biological Fixation of Nitrogen

As stated before, nitrogen is generally the most important element that can be added to forest soil to improve tree growth. Nitrogen can be artificially added to soils or added by biological fixation. The gaseous nitrogen fixing organisms that nodulate alders and other leguminous species are known to add substantial nitrogen to forest soils. Over a 5-year period, a red alder forest contributes a conservatively estimated 690 lb/acre of nitrogen to forest soils (Tarrant and Trappe 1971).

Many factors affect the cost effectiveness of applying conventional fertilizers (urea) versus more natural methods such as retaining red alder in commercial stands dominated by conifers. Research has indicated that using red alder in some options may be a practical alternative to urea fertilization. Site, current cost of fertilizers, impact to conifer stands, and other factors need to be considered when making these decisions. Stands within the watershed vary greatly in composition from almost pure red alder stands to conifer stands with only a scattering of red alder.

Burning

Prescribed burning has been used in the past to remove logging debris, which inhibits reforestation efforts and poses a threat of uncontrolled wildfire. In recent years, the value of maintaining organic debris after timber harvest has surpassed the value of clearing debris for reforestation in most instances. Slash that is situated in a way that poses the risk of wildfire (large landings, heavy slash adjacent to popular roads) has been dealt with in a more site-specific approach.

Burning can result in less productive soils by depleting substrates necessary for decomposing organisms and converting much of the mineral nutrient bound in organic matter into soluble ash. Additionally, the radical decrease in green plants minimizes the living biomass reservoir into which nutrients can by cycled. Impacts are higher in soils with low organic matter content in and on surface soils and those with relatively coarse textures. Slash burning while soils are moist significantly reduces negative impacts.